Groundwater recharge estimates using a soil-water-balance model for the Powder River and Williston structural basins

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Groundwater recharge will be estimated as part of a project initiated by the U.S. Geological Survey to construct a conceptual model and water budget for the lower Tertiary and Upper Cretaceous aquifer system in the Powder River and Williston structural basins. The study area covers about 75,000 mi^2 in parts of Wyoming, Montana, and North and South Dakota. These aquifers are the shallowest and typically most accessible primary aquifers within the two structural basins. Prolific natural gas and coal production in the Powder River structural basin and oil production in the Williston structural basin will require trillions of gallons of water from this aquifer system over the next 15 years. Increasing demands for irrigation, industry, domestic, and municipal uses in this region will also affect the groundwater availability. Determining how the aquifer system will respond to these depletions is important for regional water management.

A numerical soil-water-balance (SWB) model based on a modified Thornthwaite-Mather approach will be used to estimate recharge to the aquifer system. The inputs for the SWB model include daily precipitation and temperature data, land-use classification, soil type, and surface-water flow direction. A numerical grid will be placed over the region, and the sources and sinks of water within each grid cell will be determined by the SWB model based upon the input data. Recharge is then calculated as the difference between the change in soil moisture and the flow rates of sources and sinks. The model will be run on a daily time-step over a 50-year period (1961-2010). Monthly recharge to the aquifer system will be recorded and incorporated into a conceptual model generalizing the water budget of the aquifer system within each structural basin.